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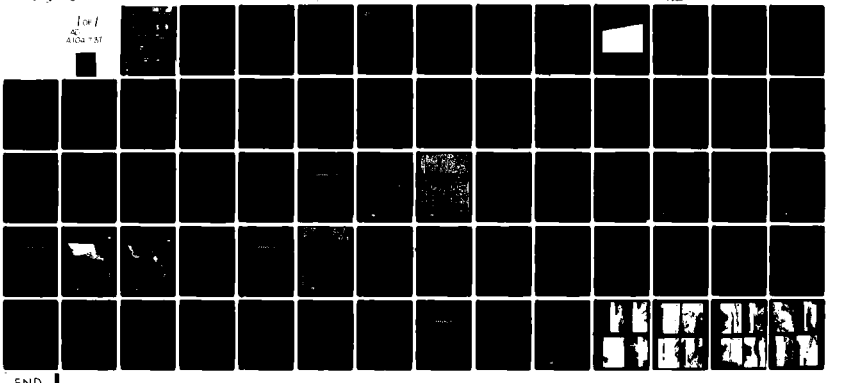

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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

'UBBLEFIELD LAKE DAM

RAWFORD COUNTY, MISSOURI

O 38363

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
... Serving the Army
... Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER, 1980

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National Dam Safety Program
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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Stubblefield Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Stubblefield Dam (MO 30363).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 02 APR 1981 — Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 03 APR 1981 — Date

MISSISSIPPI-KASKASKIA-ST LOUIS RIVER BASIN

STUBBLEFIELD LAKE DAM

CRAWFORD COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30363

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

December 1980

PHASE 1 REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam:	Stubblefield Lake Dam
State Located:	Missouri
County Located:	Crawford
Stream:	Tributary of Brush Creek
Date of Inspection:	6 October 1980

Stubblefield Lake Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 3 miles downstream of the dam. Located within this zone are three dwellings and three buildings. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken. The dam is in the small size classification, since it is greater than 25 ft high but less than 40 ft high, and the maximum storage capacity is greater than 50 acre-ft but less than 1,000 acre-ft.

Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 30 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the low height of the dam and the small storage capacity, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The 1 percent probability flood will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.

Deficiencies visually observed by the inspection team were: (1) scattered trees and brush on both the upstream and downstream face; (2) lack of wave protection for the upstream embankment face; (3) minor erosion at the left downstream dam-abutment contact; (4) minor slough above the outlet of the drawdown pipe; and (5) possible seepage area beyond the downstream toe on the left side of the valley. Another deficiency was the lack of seepage and stability analysis records.

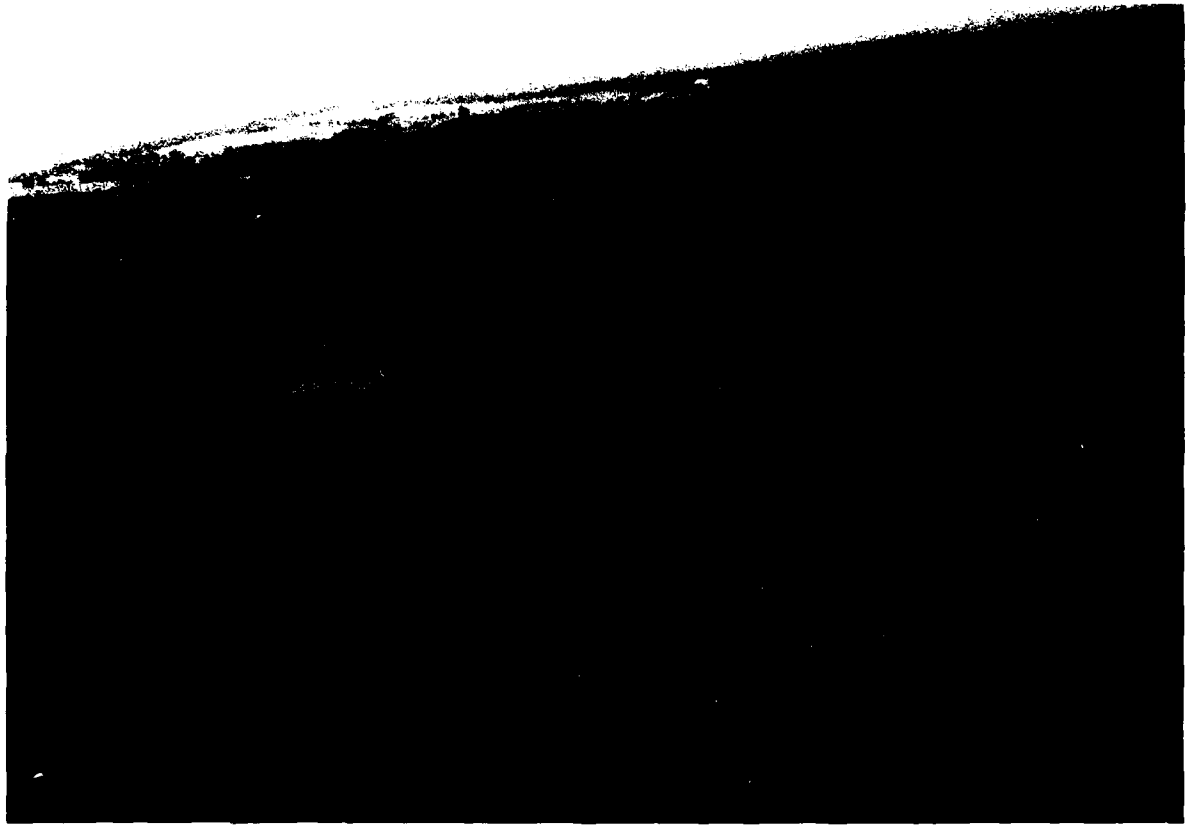
It is recommended that the owners take the necessary action promptly to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

Steve Brady, P.E. (AEI)

Tom Beckley, P.E. (AEI)

Gene Wertepny, P.E. (HEI)

Dan Kerns, P.E. (HEI)



AERIAL VIEW OF LAKE AND DAM

Table of Contents

APPENDICES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Stubblefield Lake Dam in Crawford County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Stubblefield Lake Dam is an earth fill structure approximately 29 ft high and 550 ft long at the crest. In this report, right and left orientation is based on looking in the downstream direction. The appurtenant works consist of an earth cut swale with concrete control section in the right abutment (principal spillway) and an earth cut swale in the left abutment (emergency spillway). A 4 in. drawdown pipe with a valve on the upstream end (under water) is located near the center of the dam. Information from the owner of the dam indicates that the entrance invert of the pipe is approximately 6 ft below normal pool (elevation 924). The exit invert of the pipe as determined during the inspection is at elevation 917.9 (see Sheet 3 of Appendix A). Sheet 3 of Appendix A shows a plan, profile, and typical section of the

embankment. Sheet 4 of Appendix A shows a section and profile of the principal spillway.

B. Location:

The dam is located in the northwest part of Crawford County, Missouri on a tributary of Brush Creek. The dam and lake are within the Oak Hill, Missouri 7.5 minute quadrangle sheet (Section 32, T40N, R4W-latitude 38 deg., 9.8 min. , longitude 91 deg., 24.2 min.). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 29 ft and a maximum storage capacity of approximately 177 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification. The estimated damage zone extends approximately 3 miles downstream of the dam. Located within this zone are three dwellings and three buildings. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken.

E. Ownership:

The dam is owned by David Workman. The owner's address is Box 255, Cuba, Missouri 65453 (telephone: 314-885-2775).

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes.

G. Design and Construction History:

The dam was constructed in 1964 by a Mr. Eadle of Owensville, Missouri. The owner indicated that the embankment materials were "red clays" taken mainly from the lake area, and that there is a 12 ft wide clay cutoff, which extends 6 ft below the base of the dam. The only modification to the dam was made about 5 years ago when the principal spillway was extended by means of a low earth berm on the left side for 400 ft downstream of the crest of the dam (see Sheets 3 and 6 of Appendix A). This was done to prevent erosion of the downstream face of the dam.

Another dam and lake (hereinafter referred to as the "upper dam"

or "upper lake") were constructed in about 1969 approximately 1,000 ft upstream of Stubblefield Dam (see "Aerial View of Lake and Dam" in the beginning of this report). This dam is approximately 22 ft high and 400 ft long with the top of dam at elevation 949.5 and the crest of the spillway at elevation 947.3. A profile of the upper dam (looking downstream) is presented on Sheet 5 of Appendix A. The effect of the upper dam was considered in the routing analysis as explained in Section 5 of the text and in Appendix C.

H. Normal Operating Procedures:

Normal flows are discharged over uncontrolled earth swale spillways. The drawdown pipe has been used only once (10 yrs ago) when the water was lowered several feet for shoreline dock repairs. The owner reported that the highest water level was more than 1 ft above the principal spillway crest last summer after a 5 in. rain. He also indicated that the emergency spillway has never been used.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the USGS quad sheet, is approximately 164 acres.

B. Discharge at Dam Site:

(1) All discharge at the dam site is through uncontrolled spillways.

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 932.5): 455 cfs

(3) Estimated Capacity of Primary Spillway: 240 cfs

(4) Estimated Experienced Maximum Flood at Dam Site: Unknown

(5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(7) Gated Spillway Capacity at Pool Elevation: Not Applicable

(8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 930.0 for the concrete slab in the spillway at station 0+60, 10 ft left of the centerline of the dam (estimated from quadrangle map). The control section of the principal spillway is actually 39 ft left (downstream) of the centerline of the dam (higher elevation than the concrete slab).

(1) Top of Dam: 932.5

(2) Principal Spillway Crest: 930.1

(3) Emergency Spillway Crest: 931.4

(4) Principal Outlet Pipe Invert: Not Applicable

(5) Streambed at Centerline of Dam: 903.6

(6) Pool on Date of Inspection: 928.8

(7) Apparent High Water Mark: Not Evident

(8) Maximum Tailwater: Unknown

(9) Upstream Portal Invert Diversion Tunnel: Not Applicable

(10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Top of Dam: 1,070 ft

(2) At Principal Spillway Crest: 950 ft

(3) At Emergency Spillway Crest: 1,020 ft

E. Storage Capacities:

(1) At Principal Spillway Crest: 140 acre-ft

(2) At Top of Dam: 177 acre-ft

(3) At Emergency Spillway Crest: 159 acre-ft

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 13 acres

(2) At Top of Dam: 17.5 acres

(3) At Emergency Spillway Crest: 15.5

G. Dam:

(1) Type: Earth

(2) Length at Crest: 550 ft

(3) Height: 29 ft

(4) Top Width: 12 ft

(5) Side Slopes: Upstream Varies--See Sheet 3, App. A,
Downstream Varies--See Sheet 3, App. A

(6) Zoning: None (From Owner)

(7) Impervious Core: None (From Owner)

(8) Cutoff: 12 ft wide, 6 ft deep
(From Owner)

(9) Grout Curtain: None (From Owner)

H. Diversion and Regulating Tunnel:

(1) Type: Not Applicable

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Drawdown Pipe Valve (under water)

I. Spillway:

I.1 Principal Spillway:

(1) Location: Right Abutment

(2) Type: Earth Cut Swale With Concrete Slab at Crest

I.2 Emergency Spillway:

(1) Location: Left Abutment

(2) Type: Earth Swale

J. Regulating Outlets:

The only regulating outlet is a 4 in. diameter drawdown pipe near the center of the dam. The valve for the pipe is on the upstream end (under water). The drawdown pipe was used only once, about 10 years ago.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data exist for this dam. No documentations of construction inspection records were available. There are no documented maintenance data.

A. Surveys:

No information regarding pre-construction surveys was obtained. Sheet 3 of Appendix A presents a plan, profile, and cross section of the dam from survey data obtained during the site inspection. The crest of the principal spillway (reservoir normal pool) was used as a reference point to determine all other elevations. It is estimated that this site datum approximately corresponds to mean sea level (MSL) elevation 930.0 (estimated from quad sheet).

B. Geology and Subsurface Materials:

The site is located in the north-central portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus, and deep valleys. The most common bedrock types are dolomite, sandstone, and chert. The "Geologic Map of Missouri" indicates that the bedrock in the site area consists primarily of the Gasconade formation of the Canadian Series in the Ordovician System. The Gasconade formation is predominantly a light brownish-gray, cherty dolomite. In this area, the average thickness of the Gasconade is 200 ft. Caves and springs are common in this formation. The publication "Caves of Missouri" lists a total of seven caves known to exist in Crawford County. Most of these caves are clustered in a 3 sq mile area about 12 miles southeast of the site.

The "Geologic Map of Missouri" indicates a normal fault passing about 10 miles southwest of the site in a northwest-southwest direction. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years (rock associated with the Ordovician Period - 500 million years old).

Soils in the area of the dam site appear to be primarily thin deposits of residual silts and clays with rock fragments. The soils are of the Lebanon-Nixa-Clarksville and Hobson-Clarksville Soil Associations and have developed from cherty dolomites, sandstones, and

limestone. The loessial thickness map indicates that upland areas may have between 2.5 and 5.0 ft of loess cover.

Soils in the embankment and in abutment areas near the dam are described as reddish brown clays with some silt and chert fragments (CL).

C. Foundation and Embankment Design:

No foundation or embankment design information was available. Seepage and stability analyses apparently were not performed as required in the guidelines. The owner indicated that the dam consisted of soil taken mainly from the lake area. He said that a compacted clay key was constructed to a depth of about 6 ft below the base of the dam.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design computations for this dam were available. Based on a field check of spillway dimensions and embankment elevation, and a check of the drainage area on USGS quad sheets, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C.

E. Structure:

The only appurtenant structure associated with this dam is a 4 in. diameter cast iron drawdown pipe with the valve on the upstream end (under water). There are no other structures.

2.2 CONSTRUCTION:

No construction inspection data were available.

2.3 OPERATION:

Normal flows are passed by uncontrolled earth cut spillways. The only operating facility is a 4 in. diameter steel drawdown pipe through the center of the dam which has not been operated for 10 years.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on 6 October 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Andersor Engineering, Inc. (Civil Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)
Dan Kerns - Hanson Engineers, Inc. (Geotechnical Engineer)
The owner was not on site during the inspection.

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam appears to be in good condition. There is some brush and small tree growth on the upstream face particularly near the center of the dam (see Photos 2 and 3). There is no wave protection on the upstream face, but no significant sloughing was observed.

The crest of the dam is clear and mowed. It appeared uniform both vertically and horizontally, and no cracking or unusual movement was observed (see Photos 4 and 5). The downstream face was covered with medium to tall grass and had some widely scattered brush and small tree growth (see Photos 6 and 7). Some fairly large (6 in. to 8 in.) willow trees have been cut within the last year.

Some minor irregularities (slight bulges probably from the time of construction) were noted in the slope, but they did not appear to be serious. A small slough (5 ft wide, 3 ft deep) was noted just above the drawdown pipe outlet. The slough appeared to be fairly old and not active.

Some minor erosion was noted at the left abutment-dam contact. The right contact area did not exhibit any erosion.

Auger probes in the embankment indicated a reddish brown clay with some silt and chert fragments (CL).

An area of marsh vegetation was noted beyond the toe on the left side of the valley (see Photo No. 8). No flow was noted on the day of inspection.

C. Appurtenant Structures:

C.1 Principal Spillway:

The principal spillway is an earth cut overflow in the right abutment. The spillway outlet channel is channelized for 400 ft by a low earth berm, and outlet flows are well separated from the dam. The crest of the spillway is protected by a 30 ft long by 10 ft wide concrete slab. The approach area and outlet area are clear (see Photos 9, 10, and 11). The concrete slab is in good condition.

There is a 4 in. diameter cast iron drawdown pipe located in about the center of the dam. The pipe outlets on the downstream face of the dam (outlet invert elevation 917.9). The owner reported that the valve is on the inlet end of the pipe 6 ft below normal pool. The pipe has not been used for 10 years (see Photo No. 14).

C.2 Emergency Spillway:

The emergency spillway is an earth swale in the left abutment. The approach and outlet areas are clear. There is no permanent control section, nor is there any particular channelization of the outlet channel (see Photos 12 and 13). According to the owner, the emergency spillway has never been used.

D. Reservoir:

The total watershed is approximately 44 percent wooded, 45 percent pasture, and 11 percent lake surface. Approximately 41 percent of the total watershed is an upstream lake and watershed. The upper dam and lake were considered in the hydrology and hydraulics analyses as discussed in Section 5 and Appendix C.

The slopes adjacent to Stubblefield Lake are moderate, and no sloughing or serious erosion was noted. No significant sedimentation was observed.

E. Downstream Channel:

The downstream channel is fairly well defined and heavily wooded immediately downstream of the downstream toe of the dam.

3.2 EVALUATION:

Trees and brush on the dam constitute a potential seepage hazard and encourage animal burrowing. There is no wave protection provided for the upstream face of the embankment. The eroded areas and old slough should be repaired. The area of marsh vegetation near the downstream toe should be monitored to be sure that this is not the result of seepage under the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

The only operating facility is the valve for the 4 in. diameter drawdown pipe, which is under water and has not been operated for years. The pool is normally controlled by rainfall, runoff, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM:

Some maintenance of the dam has been done. The crest was mowed, and some fairly large trees have recently been cut on the downstream face.

4.3 MAINTENANCE OF OPERATING FACILITIES:

There is no regular maintenance of operating facilities.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The vegetation on the dam, lack of riprap, and eroded areas are deficiencies which could become serious if not corrected. A program of regular operation and maintenance of the drawdown pipe valve should be established.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. The owner of the dam indicated that the maximum depth of water over the principal spillway was more than 1 ft last year after a 5 in. rain. The emergency spillway has never been used.

C. Visual Observations:

The approach and outlet areas for both spillways are clear. There is a 30 ft long by 10 ft wide concrete slab in the crest area of the principal spillway. There is no non-erodible control section in the emergency spillway area. The principal spillway outlet channel is well separated from the embankment by a 400 ft long earth berm, and spillway releases would not be expected to endanger the dam.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U.S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevations, and (2) an estimate of the reservoir storage and the pool and drainage areas from the Oak Hill Missouri, 7.5 minute USGS quad sheet.

Based on the hydrologic and hydraulic analysis presented in Appendix C, the combined spillways will pass 30 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the low height of the dam and the small storage capacity, 50 percent of

the PMF has been determined to be the appropriate spillway design flood. The spillways will pass the 1 percent probability flood without overtopping the dam.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 3,655 cfs. For 50 percent of the PMP, the peak inflow was 1,733 cfs.

The routing of the PMF through the spillways and dam indicates that the dam will be overtopped by 1.4 ft at elevation 933.9. The duration of the overtopping will be 4.4 hours, and the maximum outflow will be 3,070 cfs. The maximum discharge capacity of the spillways is 455 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 0.65 ft at elevation 933.2. The maximum outflow will be 1,141 cfs, and the duration of overtopping will be 1.0 hours. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

A portion (67 acres) of Stubblefield Lake Dam watershed is controlled by a dam and reservoir (upper dam). This dam is 22 ft high and approximately 400 ft long. The reservoir surface area at normal pool is 5 acres and at top of dam is 6.3 acres. The reservoir storage is approximately 41 acre-ft at normal pool and 53 acre-ft at top of dam. The dam has a grassed earth cut spillway with a maximum capacity of 53 cfs at top of dam elevation. The downstream toe of the dam is about 2 ft below the normal pool elevation of Stubblefield Lake Dam.

To consider the effect of the upper dam, the outflow hydrograph of the upper dam was combined with the inflow hydrograph of Stubblefield Lake Dam (lower dam). Then, the combined hydrograph was routed through the lake and spillways of the lower dam.

The effect of the upper dam was studied, assuming that (1) the upper dam will resist the overtopping and (2) that the upper dam will breach during overtopping.

The routing study indicates that a breach of the upper dam will not significantly increase the overtopping potential of Stubblefield Lake Dam.

The following parameters were used in the breach analysis ($B cards of input data, Sheet 14, Appendix C):

1) Breach bottom width = 10 ft
2) Side slope of breach (z) = 0.5H to 1.0V
3) Breach bottom elevation = 930.0
4) Failure time = 1/2 hr (Plan 1) and 1.0 hr (Plan 2)

5) Initial water surface elevation = 947.3 (Normal pool)
6) Failure elevation = 950.5 (PMF Water surface elevation)

Failure elevation = 949.5 was also studied, but the result was less significant than assuming 950.5.

The computer input and a summary of the computer output are shown on sheets 14, 15, and 16 of Appendix C.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1.B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The only post construction change was the construction of a 400 ft long earth berm on the left side of the principal spillway about 5 years ago. This was done to direct spillway flows away from the dam.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected, or controlled. These items are: (1) scattered trees and brush on both the upstream and downstream faces; (2) lack of wave protection for the upstream embankment face; (3) minor erosion at the left downstream dam-abutment contact; (4) minor slough above the outlet of the drawdown pipe; and (5) possible seepage area beyond the downstream toe on the left side of the valley.

Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 30 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

If the deficiencies listed in paragraph 7.1 A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the

future. The items recommended in paragraph 7.2 should be pursued promptly.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

(1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.

B. O and M Procedures:

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.

(2) The small tree and brush growth on the dam should be cut periodically.

(3) Wave protection should be provided for the upstream face of the dam.

(4) The possible seepage area previously described should be inspected periodically to determine if this is seepage under the dam from the lake. If measurable flows are detected in the future, the area should be investigated by an engineer experienced in the design and construction of dams.

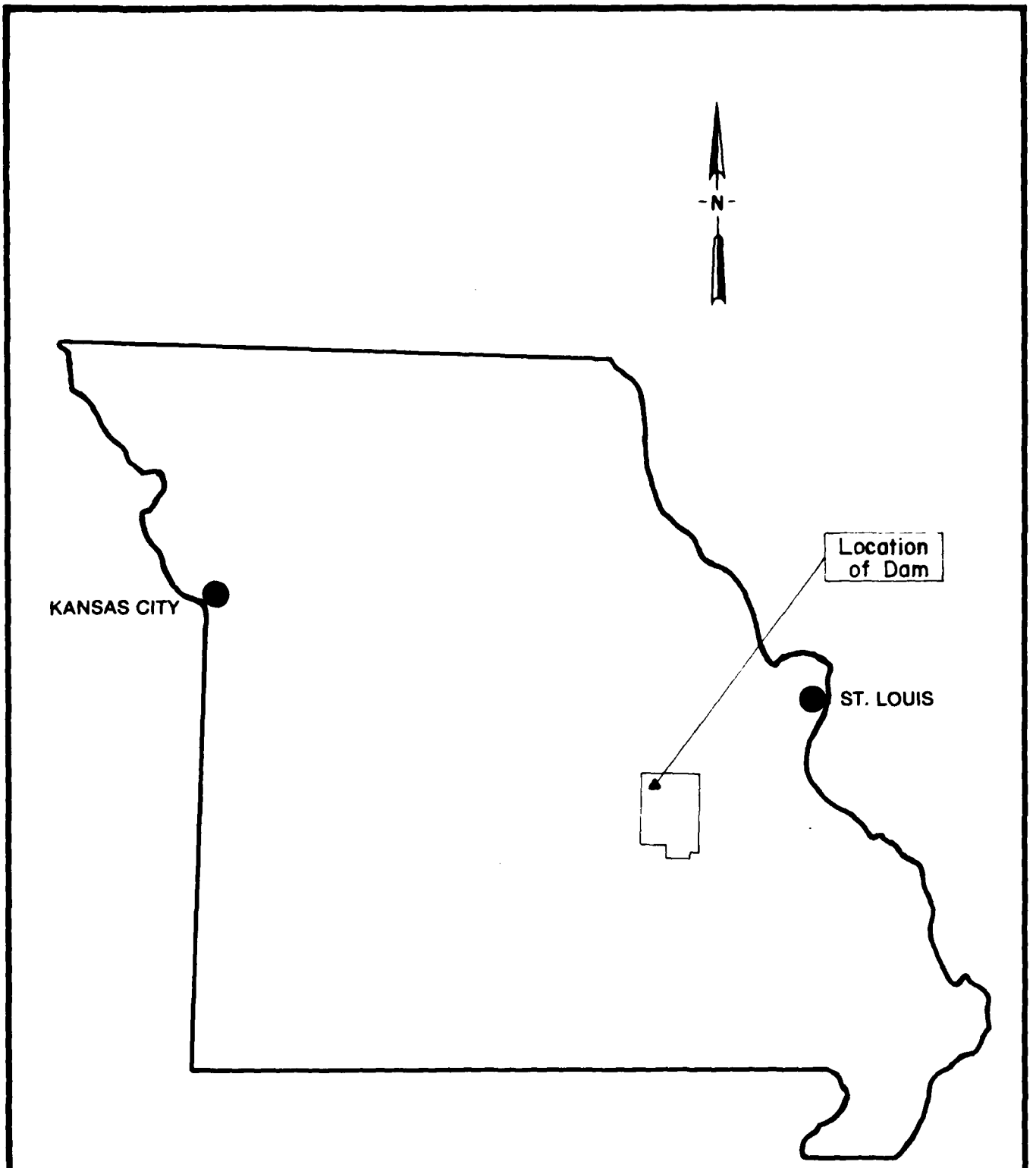
(5) Eroded and sloughed areas should be repaired and maintained.

(6) The drawdown pipe valve should be operated periodically and maintained.

(7) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans



LOCATION MAP

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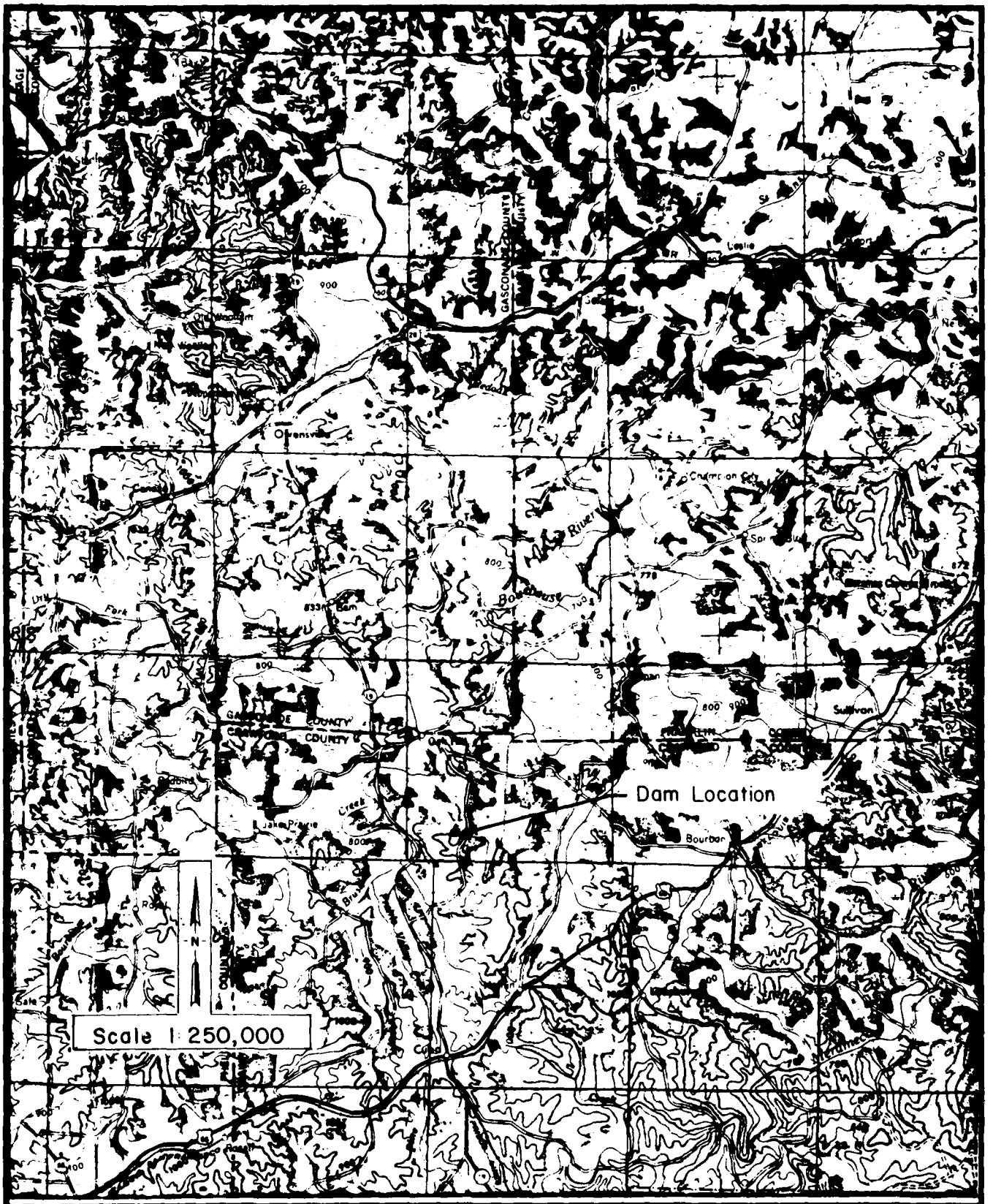
Stubblefield Lake Dam
Crawford County, Missouri
Mo. I.D. No. 30363

SHEET 1, APPENDIX A



VICINITY MAP

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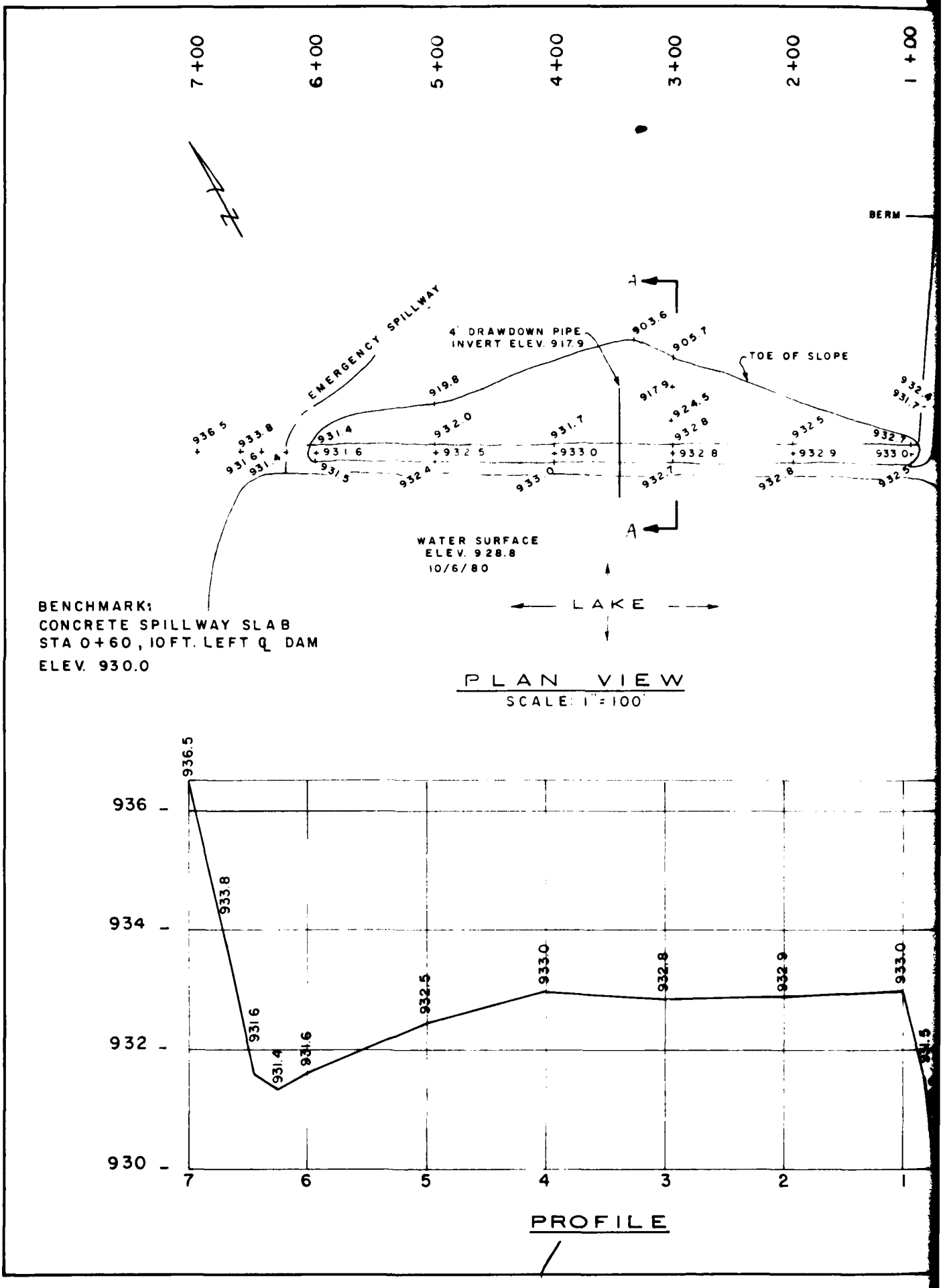
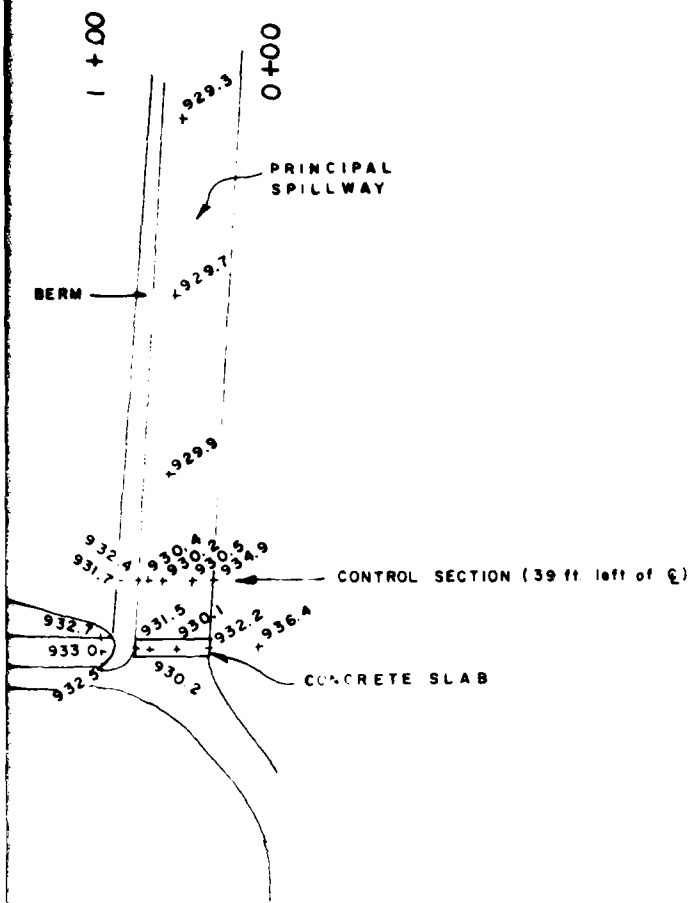
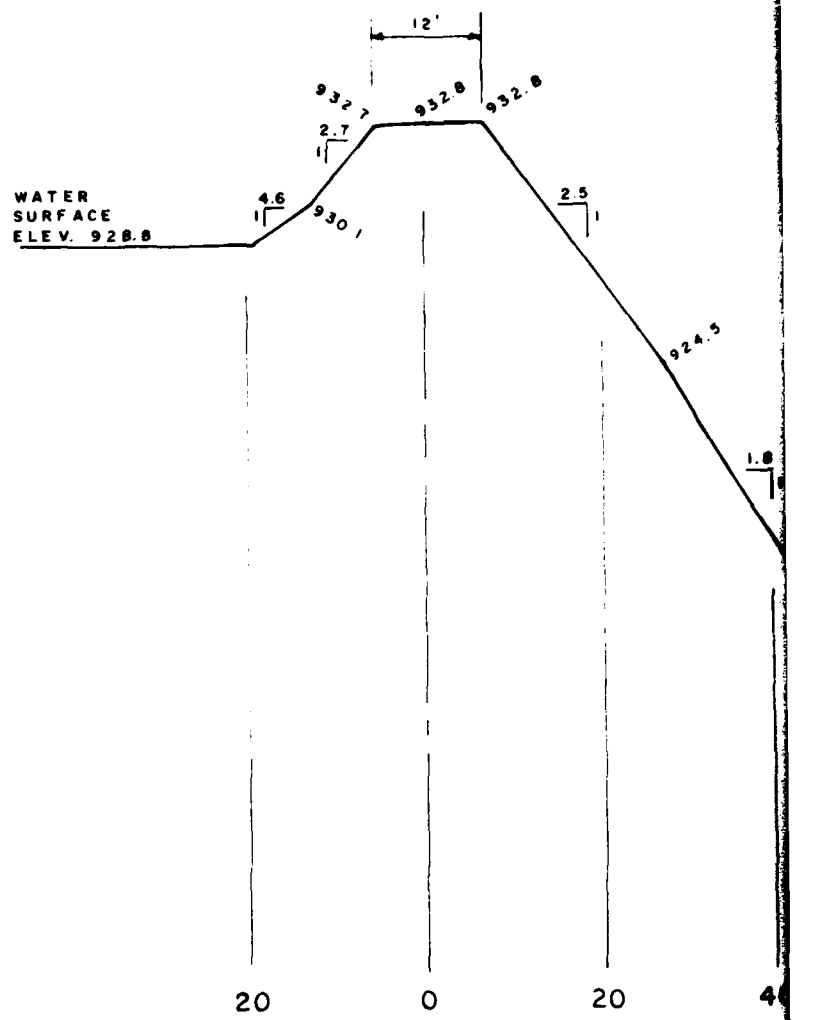
Stubblefield Lake Dam
Crawford County, Missouri
Mo. I.D. No. 30363

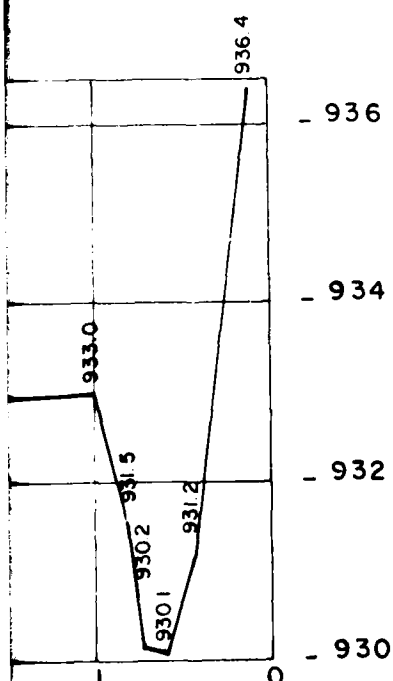
Sheet 2, Appendix A

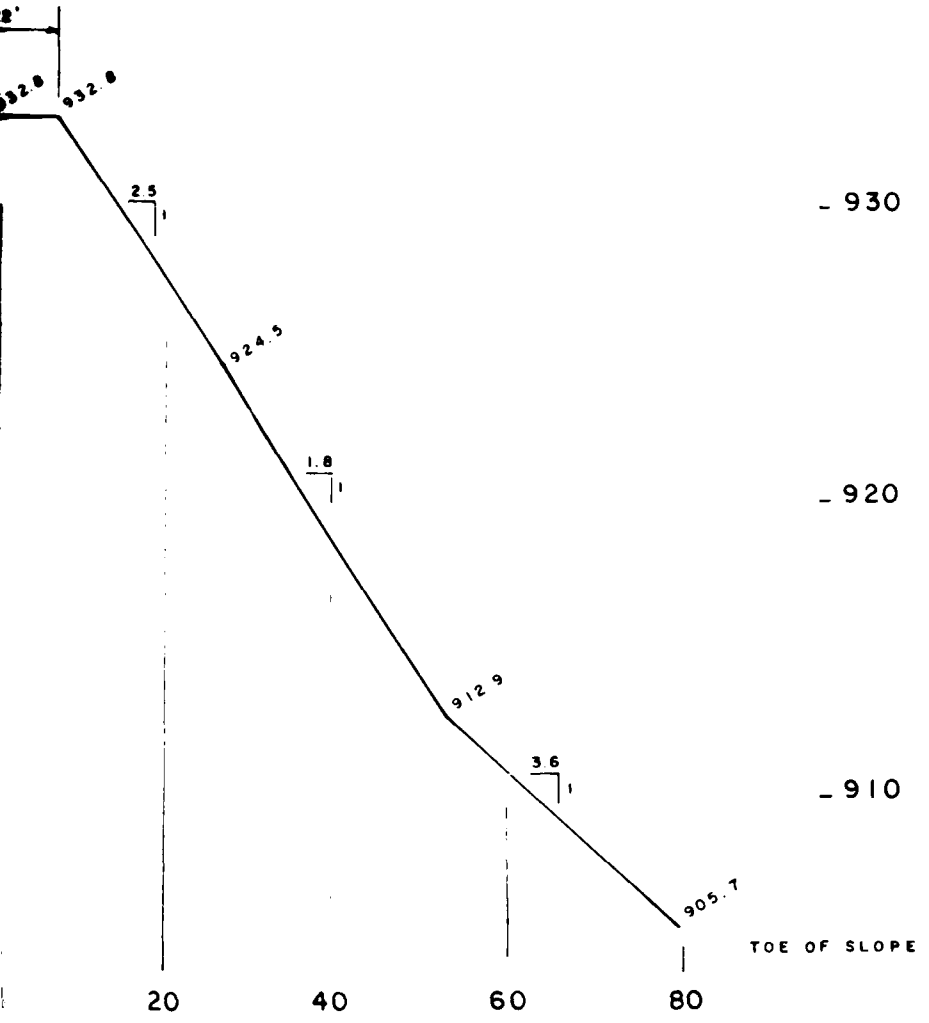

7+00
6+00
5+00
4+00
3+00
2+00
1+00
BERM
A
A
EMERGENCY SPILLWAY
4" DRAWDOWN PIPE
INVERT ELEV. 917.9
903.6
905.7
TOE OF SLOPE
919.8
917.9
936.5
933.8
931.6
931.4
931.4
931.5
932.0
932.4
931.7
933.0
924.5
932.8
932.7
932.5
932.7
933.0
932.8
932.5
931.7
WATER SURFACE
ELEV. 928.8
10/6/80
LAKE
BENCHMARK:
CONCRETE SPILLWAY SLAB
STA 0+60, 10FT. LEFT ℄ DAM
ELEV. 930.0
PLAN VIEW
SCALE: 1"=100'
936
934
932
930
936.5
933.8
931.6
931.4
931.6
932.5
933.0
932.8
932.9
933.0
7
6
5
4
3
2
1
PROFILE





SECTION A-A STA 3+





ON A-A STA 3+00

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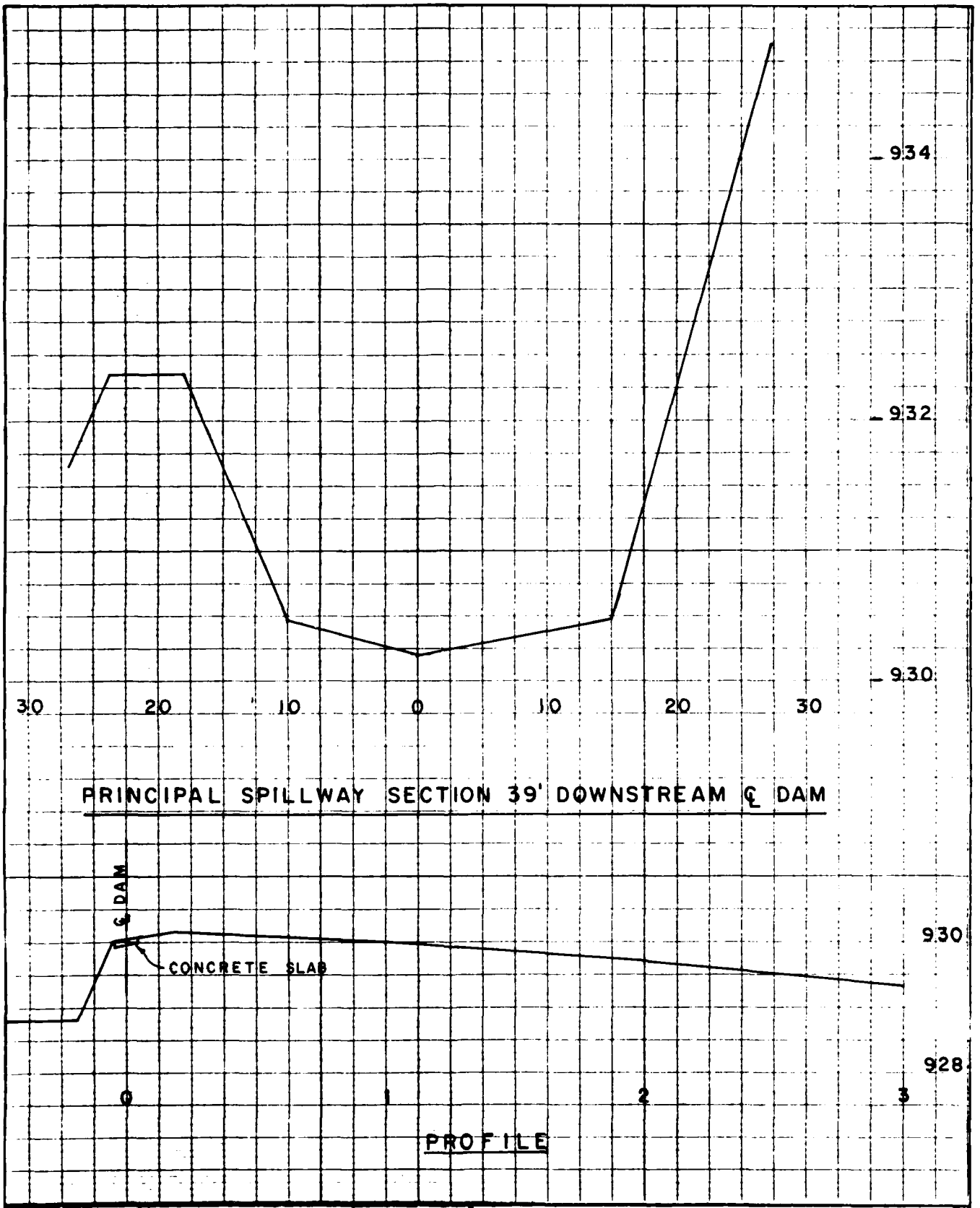
MO. No. 30363	
PLAN & PROFILE	
CRAWFORD COUNTY, MO.	
SHEET 3 , APPENDIX A	

3



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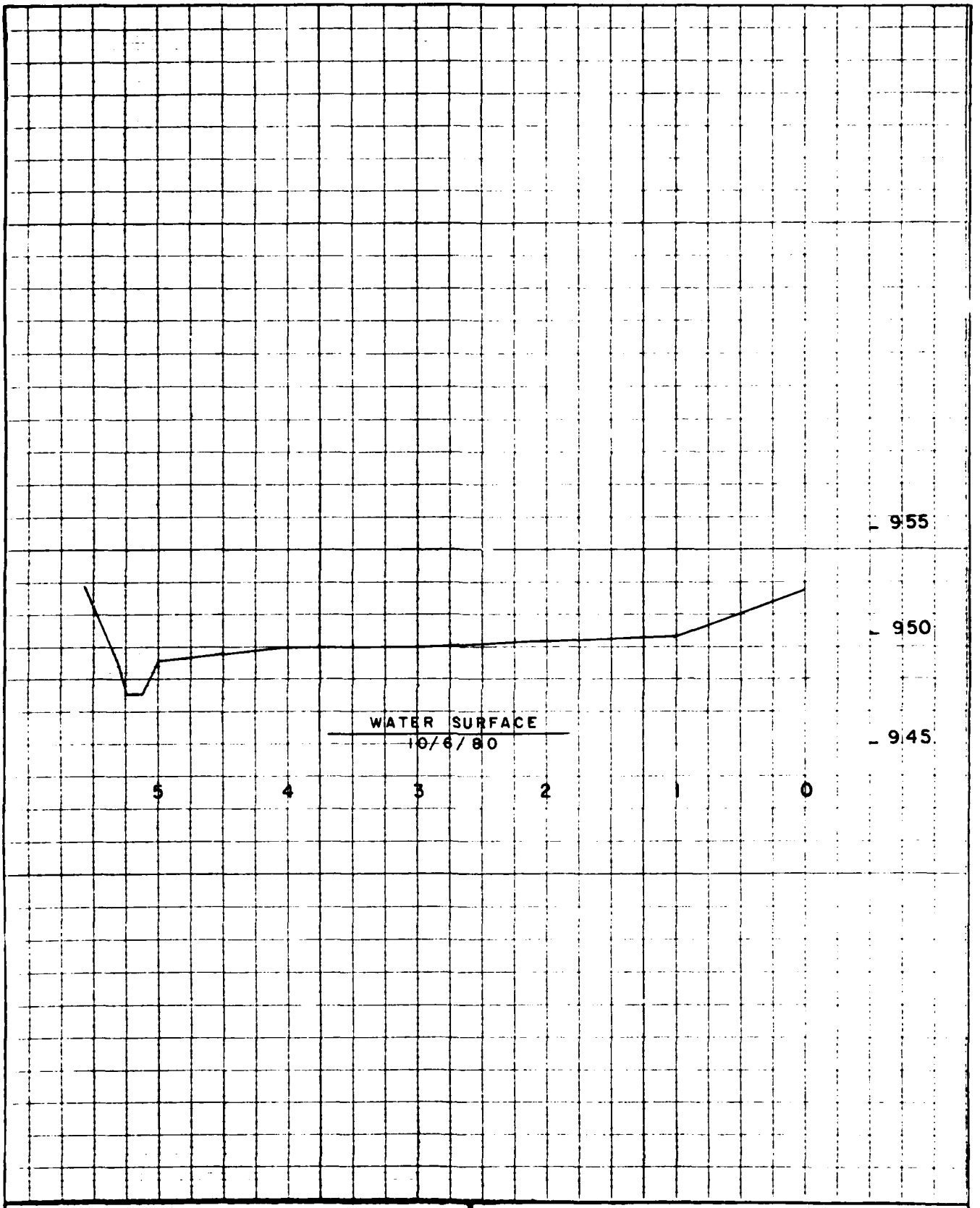
STUBBLEFIELD LAKE DAM
CRAWFORD COUNTY, MISSOURI
MO. I.D. No. 30363

Principal Spillway - Section & Profile

SHEET 4 , APPENDIX A



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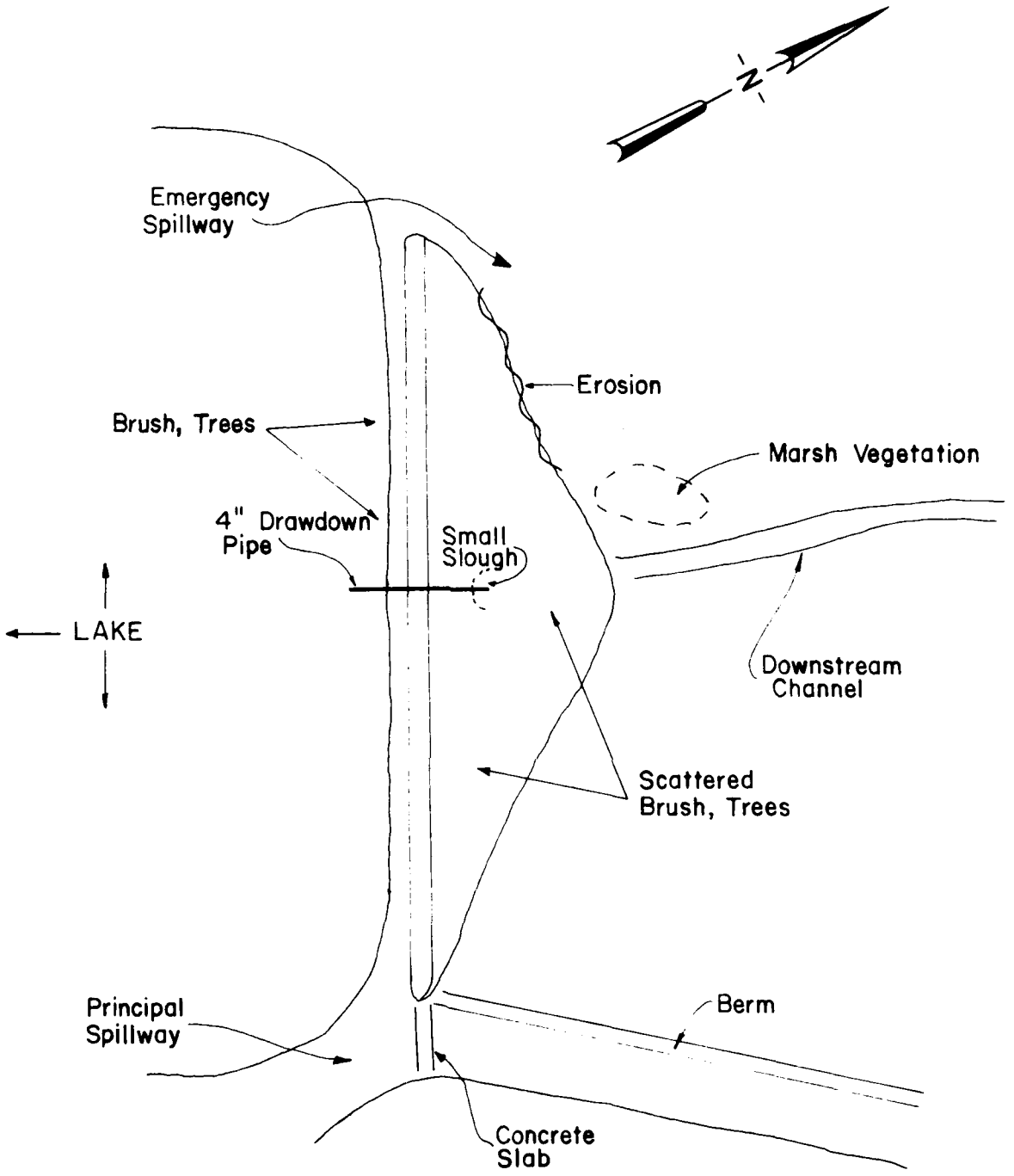
STUBBLEFIELD LAKE DAM
CRAWFORD COUNTY, MISSOURI
MO. I.D. No. 30363

DAM PROFILE- UPPER LAKE

SHEET 5 , APPENDIX A



PLAN SKETCH OF FEATURES

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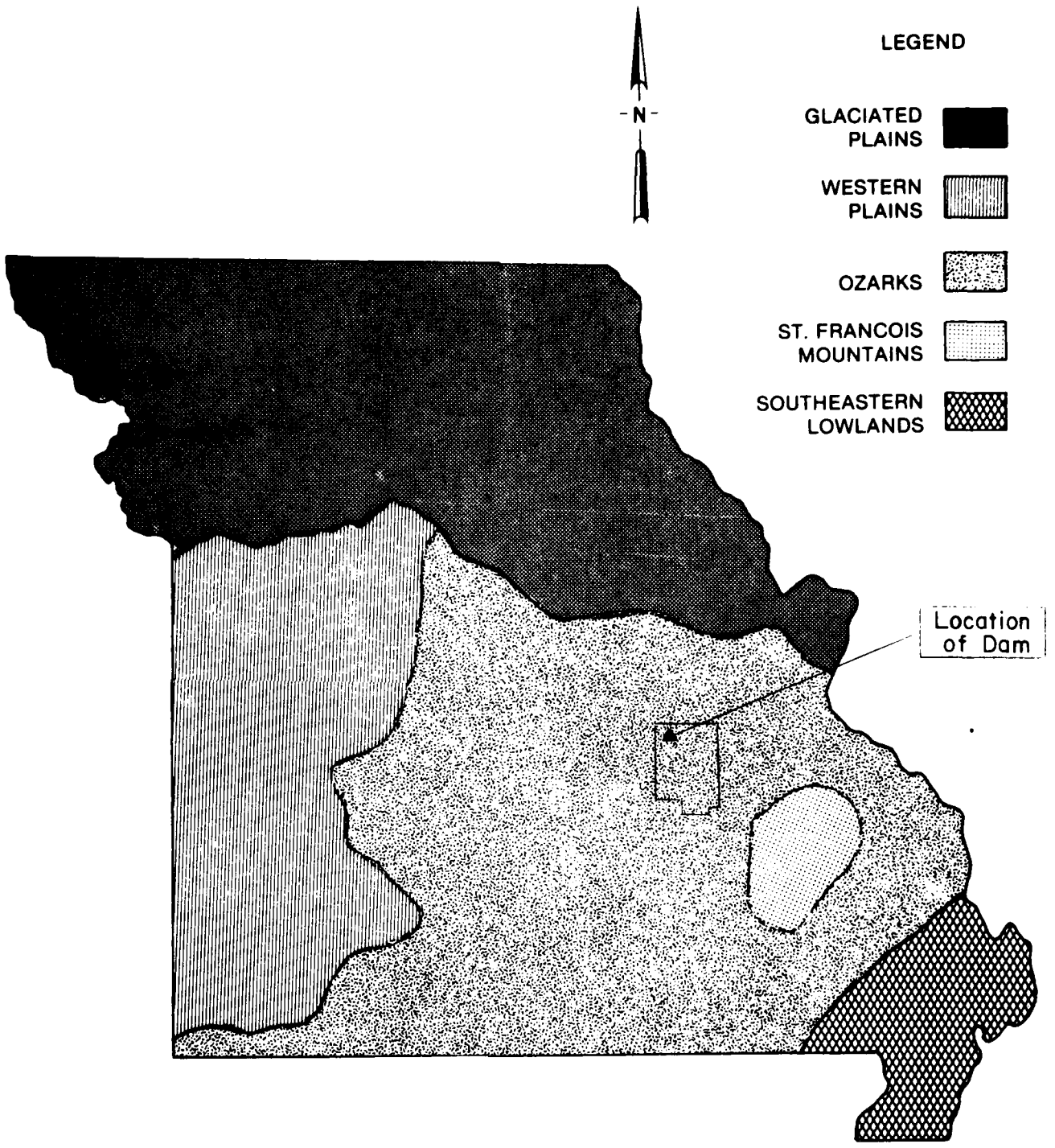
Stubblefield Lake Dam
Crawford County, Missouri
Mo I D No 30363

Sheet 6, Appendix A

APPENDIX B

Geology and Soils



MAJOR GEOLOGIC REGIONS OF MISSOURI

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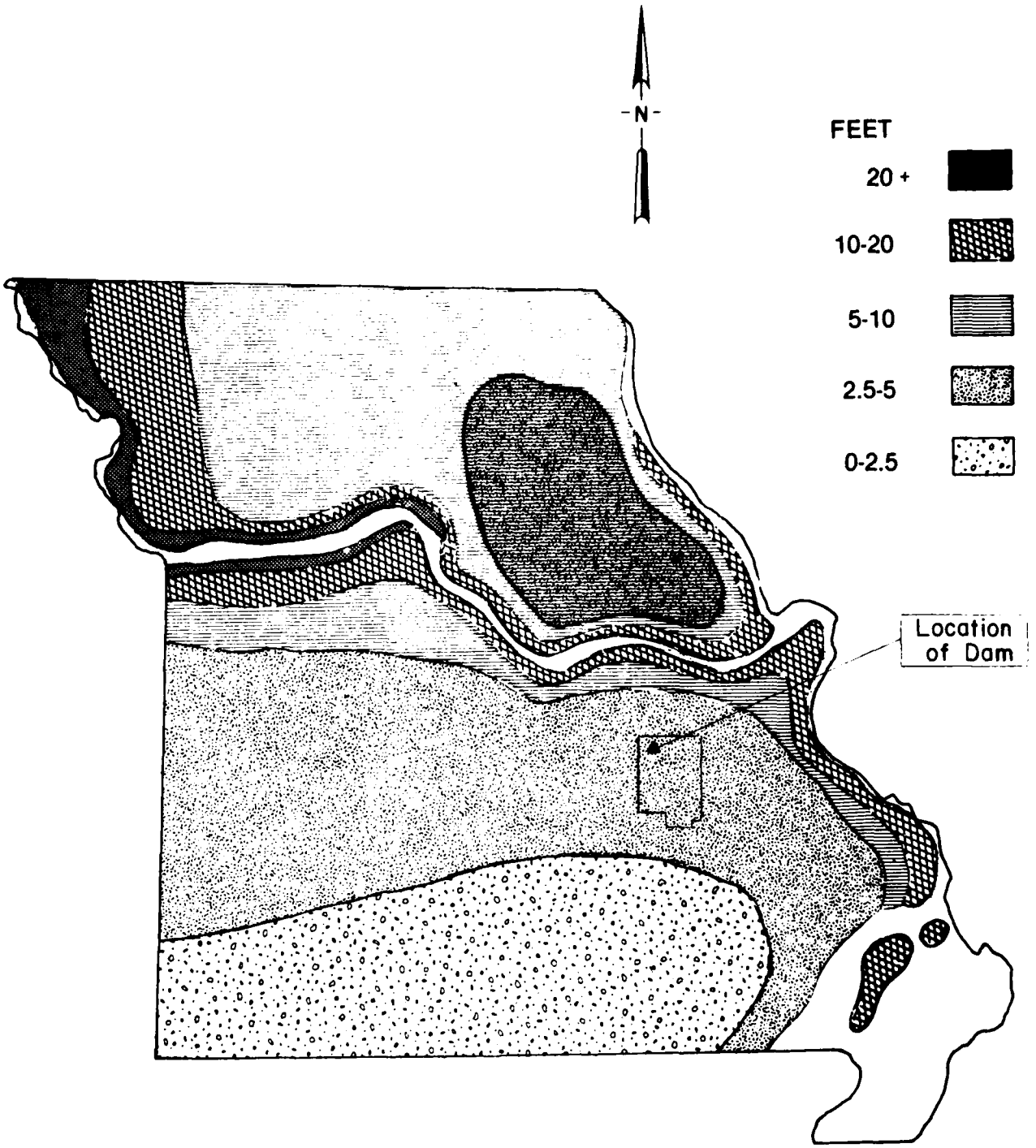
Stubblefield Lake Dam
Crawford County, Missouri
Mo. I.D. No. 30363

SHEET 1, APPENDIX B



THICKNESS OF LOESSIAL DEPOSITS

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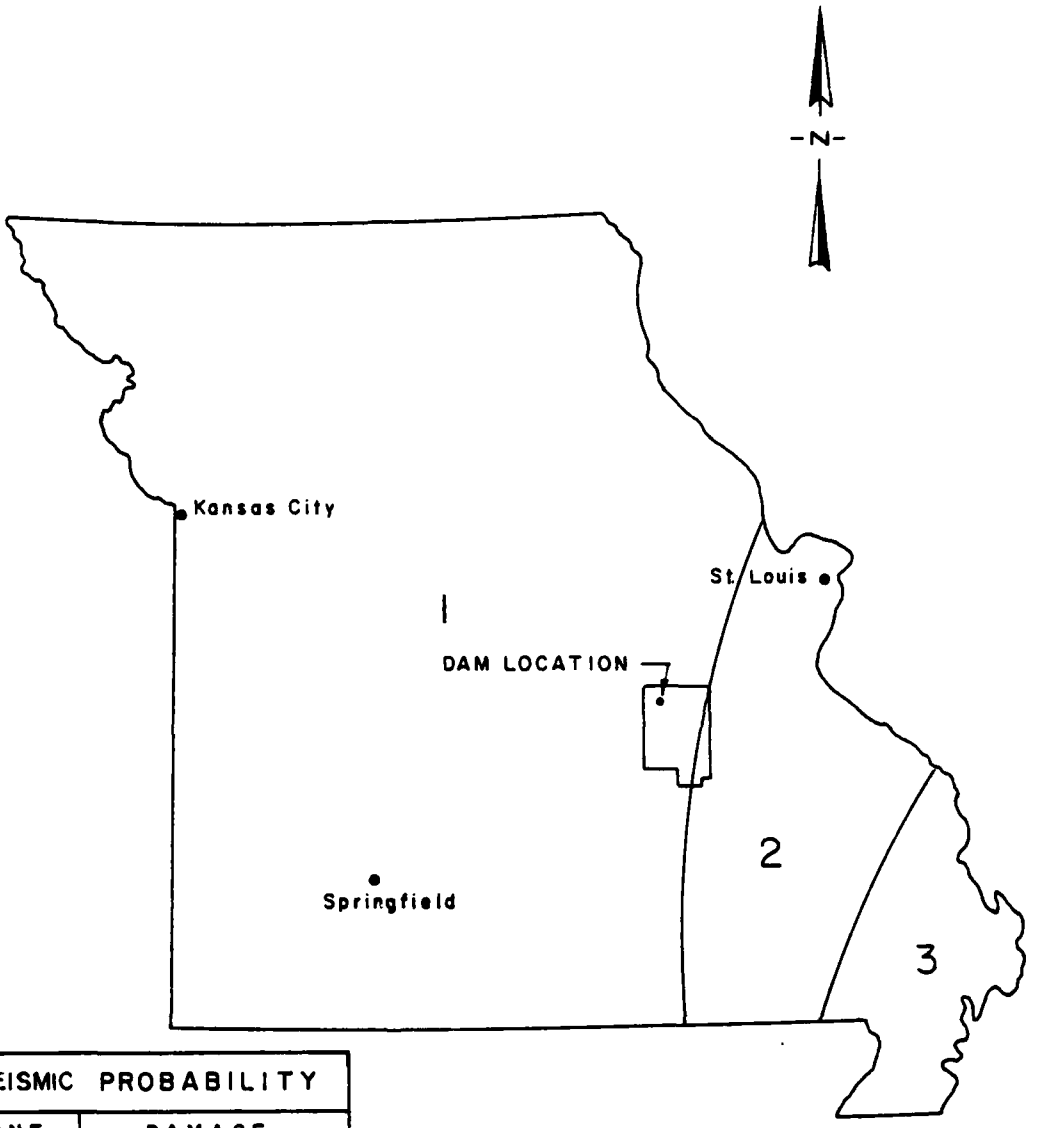
Stubblefield Lake Dam
Crawford County, Missouri
Mo. I.D. No. 30363

SHEET 2, APPENDIX B



SEISMIC PROBABILITY	
ZONE	DAMAGE
1	MINOR
2	MODERATE
3	MAJOR

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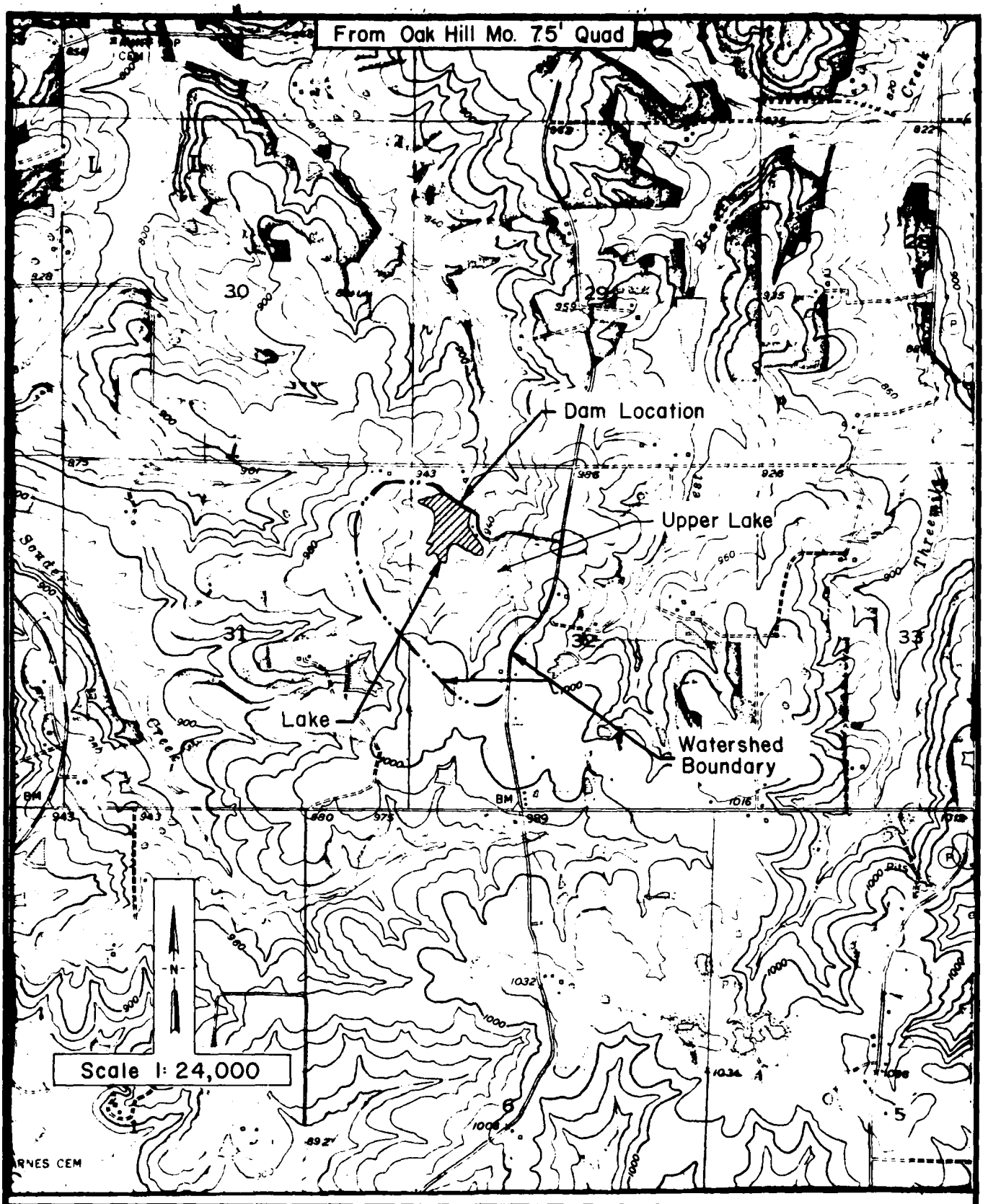
SEISMIC ZONE MAP

STUBBLEFIELD LAKE DAM
CRAWFORD COUNTY, MISSOURI
MO. I. D. No. 30363

SHEET 3, APPENDIX B

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP

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Stubblefield Lake Dam
Crawford County, Missouri
Mo. I.D. No. 30363

Sheet 1, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMF storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. Sullivan, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The time of concentration was estimated using the Kirpich formula. This formula and the parameters for the unit hydrograph are shown in Table 1 (Sheet 4, Appendix C). The time of concentration was also verified from velocity estimates for the average slopes of the watershed and the main channel (Design of Small Dams, page 70, 1974 Edition).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2 (Sheet 5, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method assuming the starting lake elevation at normal pool. No antecedent storm was considered in this case. It was assumed that the mean annual high water elevation corresponds to the normal pool elevation. The hydraulic capacity of the spillways was used as an outlet control in the routing. The hydraulic capacity of the spillways and the storage capacity of the reservoir were defined by the elevation-surface area--storage-discharge relationships shown in Table 3 (Sheet 5, Appendix C). To consider the effect in the routing analysis of the upper dam (see Section 5 of this report), the routed outflow hydrograph from the upper dam was combined with the inflow hydrograph of the lower dam. Then, the combined hydrograph was routed through the reservoir and spillways of the lower dam. The effect of the upper dam was studied, assuming separately, that the upper dam will resist the overtopping and that the upper dam will breach during overtopping.

The rating curve for the spillways is shown on Table 4 Sheet 6, Appendix C. For the principal spillway, channel flow condition was assumed, and the values were determined using the step backwater computations of the computer program HEC-2, updated July 1979 (input and output data are shown on Sheets 8 and 9 of Appendix C). For the emergency spillway, critical flow conditions at the control section, and approach channel losses equal to 20 percent of the velocity head (at the control section) were assumed.

The flow over the crest of the dam during overtopping was determined using the non-level dam option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The lowest elevation of the crest of the dam, obtained from survey measurements, was assumed as top of dam elevation.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 7, Appendix C). The result of the routings indicates that the spillways will pass the 1 percent probability flood without overtopping the dam.

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 10 to 13 of Appendix C. All these data correspond to the assumption that the upper dam will not breach due to overtopping. The input and output data for the routing of the PMF, assuming the breach of the upper dam, are shown on Sheets 14, 15, and 16 of Appendix C.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH
(LOWER DAM)

Parameters:

Drainage Area (A)	.152	sq miles(*)
Length of Watercourse (L)	0.40	miles
Difference in elevation (H)	90	ft
Time of concentration (Tc)	0.16	hrs
Lag Time (Lg)	0.10	hrs
Time to peak (Tp)	0.14	hrs
Peak Discharge (Qp)	525	cfs
Duration (D)	5	min.

Time (Min.)(**)	Discharge (cfs)(**)
0	0
5	274
10	340
15	127
20	46
25	16
30	6
35	2

(*) Total drainage area = 0.256 sq miles (164 acres)
(**) From the computer output

FORMULA USED:

$$Tc = \left(\frac{11.9\ L^3}{H}\right)^{0.385}$$

Kirpich Formula.
From California Culverts Practice, California Highways and Public Works, September, 1942.

$$Lg = 0.6\ Tc$$

$$Tp = \frac{D}{2} + Lg$$

$$Qp = \frac{484\ A.Q}{Tp}$$

Q = Excess Runoff = 1 inch

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	33.41	31.16	2.25
1% Prob. Flood	24	7.23	3.68	3.55

Additional Data:

1) Soil Conservation Service Soil Group B
2) Soil Conservation Service Runoff Curve CN = 85 (AMC III) for the PMF
3) Soil Conservation Service Runoff Curve CN = 70 (AMC II) for the 1 percent probability flood
4) Percentage of Drainage Basin Impervious 14 percent

TABLE 3

ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
904.0	0	0	-
*930.1	13.0	140	0
**931.4	15.5	159	80
***932.5	17.5	177	455
935.0	22.2	226	-
940.0	31.5	360	-

*Principal spillway crest elevation
**Emergency spillway crest elevation
***Top of dam elevation

The above relationships were developed using data from the USGS Oak Hill, Missouri 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAYS RATING CURVE

Reservoir Elevation (MSL)	Principal Spillway (cfs)	Emergency Spillway (cfs)	Total Discharge (cfs)
*930.1	0	-	0
931.2	50	-	50
**931.4	80	0	80
932.0	150	60	210
***932.5	240	215	455
932.8	300	350	650
933.25	400	620	1,020
934.0	600	1,250	1,850
934.4	730	1,740	2,470

*Principal spillway crest elevation
**Emergency spillway crest elevation
***Top of dam elevation

Method Used:

1) Principal spillway: Assuming open channel flow and using the step backwater computations of the computer program HEC-2, updated July 1979. See input and output data on Sheet 8 to 9, Appendix C.

2) Emergency spillway: Assuming critical flow conditions at the control section and the approach channel losses equal to 20 percent of the velocity head at the control section.

FORMULA: $\frac{Q^2}{g} = \frac{A^3}{T}$ Design of Small Dams, Water and Power Resources Service (Formerly USBR), page 553, 1974 Edition.

Q = Discharge in cubic feet per second
A = Cross sectional area in square feet
T = Water surface width in feet
g = Acceleration of gravity in ft/sec^2

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft, MSL)	Total Storage (acre-ft)	Peak Outflow (cfs)	Depth (ft) Over Top of Dam
-	0	*930.1	140	0	-
0.10	256	931.3	158	65	-
0.20	525	932.0	169	215	-
0.25	675	932.3	173	336	-
0.30	832	**932.5	177	455	0
0.35	1,053	932.7	181	598	0.2
0.40	1,290	932.9	185	758	0.4
0.50	1,733	933.2	190	1,141	0.7
0.75	2,719	933.6	198	2,174	1.1
1.00	3,655	933.9	205	3,070	1.4

The percentage of the PMF that will reach the top of the dam is 30 percent.

*Principal spillway crest elevation
**Top of dam elevation

```
T1       STUBBLEFIELD DAM RATING CURVE PRINCIPAL SPILLWAY (U.S. PROFILE)
T2       STARTED PROFILE AT CRITICAL DEPTH AT SECTION 1
T3       EG AT SECTION 5 ASSUMED AS RESERVOIR LEVEL FOR DISCHARGE Q
J1   -10      2                    0      -1       0                          930.0
J2     1                -1
J3    38     43       3       1      8      10      11       2      26       25
QT     7     50     150     300    400     600     900    1200
NC 0.025  0.025   0.025      .1     .3
X1     1      5       0      45      0       0       0
X3    10
GR 931.6      0   929.6       8  929.3      18   929.7      33   934.1       45
X1     2      5       0      45    100     100     100
GR 932.0      0   930.0       8  929.7      18   930.1      33   934.5       45
X1     3      5       0      45    100     100     100
GR 932.2      0   930.2       8  929.9      18   930.3      33   934.7       45
X1     4      5       0      45     60      60      60
GR 932.4      0   930.4       8  930.1      18   930.5      33   934.9       45
X1     5      6       0      88     40      40      40
GR 933.0      0   931.5      19  930.2      27   930.1      41   931.2       58
GR 936.4     88
EJ
T1
T2
T3
J1             3                    -1                                     930.2
J2     2               -1
T1
T2
T3
J1             4                    -1                                     930.4
J2     3               -1
T1
T2
T3
J1             5                    -1                                     930.7
J2     4               -1
T1
T2
T3
J1             6                    -1                                     931.0
J2     5               -1
T1
T2
T3
J1             7                    -1                                     931.2
J2     6               -1
T1
T2
T3
J1             8                    -1                                     931.4
J2    15               -1

ER
```

STEP BACKWATER COMPUTATION
HEC-2 PROGRAM
INPUT DATA

STUBBLEFIELD DAM
SUMMARY PRINTOUT

	SECNO	Q	EG	CWSEL	DEPTH	HV	HL	CRIWS	VCH	AREA
*	1.000	50.00	930.21	929.98	0.68	0.24	0.00	929.98	3.90	12.83
*	1.000	150.00	930.95	930.49	1.19	0.46	0.00	930.49	5.42	27.66
*	1.000	300.00	931.71	931.04	1.74	0.67	0.00	931.04	6.58	45.58
*	1.000	400.00	932.13	931.35	2.05	0.78	0.00	931.35	7.07	56.58
*	1.000	600.00	932.83	931.84	2.54	0.99	0.00	931.84	7.97	75.30
*	1.000	900.00	933.72	932.47	3.17	1.25	0.00	932.47	8.98	100.21
*	1.000	1200.00	934.50	933.02	3.72	1.48	0.00	933.02	9.75	123.06
	2.000	50.00	930.73	930.64	0.94	0.09	0.50	0.00	2.46	20.36
	2.000	150.00	931.49	931.27	1.57	0.22	0.52	0.00	3.78	39.66
	2.000	300.00	932.26	931.90	2.20	0.36	0.52	0.00	4.84	62.00
	2.000	400.00	932.67	932.22	2.52	0.45	0.51	0.00	5.37	74.43
	2.000	600.00	933.37	932.77	3.07	0.60	0.51	0.00	6.22	96.39
	2.000	900.00	934.27	933.46	3.76	0.81	0.50	0.00	7.22	124.67
	2.000	1200.00	935.05	934.06	4.36	0.99	0.50	0.00	7.99	150.28
	3.000	50.00	930.98	930.90	1.00	0.08	0.25	0.00	2.28	21.89
	3.000	150.00	931.77	931.59	1.69	0.18	0.28	0.00	3.41	43.93
	3.000	300.00	932.56	932.26	2.36	0.30	0.30	0.00	4.38	68.52
	3.000	400.00	932.98	932.61	2.71	0.37	0.30	0.00	4.88	81.89
	3.000	600.00	933.70	933.19	3.29	0.50	0.31	0.00	5.70	105.29
	3.000	900.00	934.61	933.93	4.03	0.68	0.33	0.00	6.61	136.23
	3.000	1200.00	935.40	934.57	4.67	0.83	0.33	0.00	7.32	164.02
	4.000	50.00	931.13	931.04	0.94	0.09	0.15	0.00	2.47	20.24
	4.000	150.00	931.93	931.73	1.63	0.20	0.15	0.00	3.58	41.88
	4.000	300.00	932.73	932.41	2.31	0.32	0.16	0.00	4.52	66.41
	4.000	400.00	933.15	932.76	2.66	0.39	0.16	0.00	5.01	79.85
	4.000	600.00	933.87	933.35	3.25	0.52	0.17	0.00	5.80	103.47
	4.000	900.00	934.79	934.10	4.00	0.69	0.17	0.00	6.68	134.65
	4.000	1200.00	935.58	934.74	4.64	0.85	0.18	0.00	7.38	162.58
	5.000	50.00	931.22	931.16	1.06	0.06	0.09	0.00	1.94	25.73
	5.000	150.00	932.02	931.91	1.81	0.11	0.08	0.00	2.62	57.29
	5.000	300.00	932.82	932.68	2.58	0.14	0.08	0.00	3.00	100.08
	5.000	400.00	933.25	933.09	2.99	0.15	0.07	0.00	3.14	127.32
	5.000	600.00	933.97	933.79	3.69	0.18	0.06	0.00	3.39	177.18
	5.000	900.00	934.90	934.69	4.59	0.21	0.06	0.00	3.67	245.08
	5.000	1200.00	935.70	935.46	5.36	0.24	0.06	0.00	3.92	306.44

STEP BACKWATER COMPUTATION
HEC-2 PROGRAM
OUTPUT DATA

```
A       OVERTOPPING ANALYSIS FOR STUBBLEFIELD LAKE DAM ( # 25 )
A       STATE ID NO. 30363  COUNTY NAME : CRAWFORD
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 80S3001
B    300                5
B1     5
J      1        9        1
J1   .10      .20      .25      .30      .35      .40      .50      .75      1.0
K      0        1                                  3        1
K1      INFLOW HYDROGRAPH COMPUTATION FOR THE UPPER LAKE
M      1        2   0.105            0.105        1                          1
P      0     25.7      102      120      130
T                                                                -1      -82             0.10
W2  0.14     0.09
X      0      -.1        2
K      1        2                             0        4        1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE (UPPER DAM)
Y                                    1        1
Y1     1                                                        41       -1
Y4 947.3    948.0    949.0    949.5    950.0    950.9    951.7
Y5     0       22       92      160      240      550      885
$S     0       41       53       63       97      152
$E 927.8    947.3    949.5    951.0    955.0    960.0
$$ 947.3
$D 949.5
$L   190      290      390      490
$V 949.5    949.8    950.1    952.1
K      0        3                                  3        1
K1      INFLOW HYDROGRAPH COMPUTATION FOR THE LOWER LAKE (STUBBLEFIELD LAKE)
M      1        2   0.152            0.152        1                          1
P      0     25.7      102      120      130
T                                                                -1      -85             0.14
W2  0.16     0.10
X      0      -.1        2
K      2        4                                  3        1
K1      COMBINE OUTFLOW HYDROGRAPH FROM UPPER LAKE AND INFLOW HYD.FOR STUBBLEFIELD LAKE
K      1        5                             0        4        1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT STUBBLEFIELD DAM SITE **
Y                                    1        1
Y1     1                                                               140       -1
Y4 930.1    931.2    931.4    932.0    932.5    932.8   933.25    934.0    934.4
Y5     0       50       80      210      455      650     1020     1850     2470
$S     0      140      159      177      226      360
$E 904.0    930.1    931.4    932.5    935.0    940.0
$$ 930.1
$D 932.5
$L     0       60      230      400      400      400      400
$V 932.5    932.8    932.9    933.0    933.5    934.0    935.0
K     99
```

PMF RATIOS
INPUT DATA
(ASSUMING NO BREACH OF THE UPPER DAM)

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.10	RATIO 2 0.20	RATIO 3 0.25	RATIO 4 0.30	RATIO 5 0.35	RATIO 6 0.40	RATIO 7 0.50	RATIO 8 0.75	RATIO 9 1.00
HYDROGRAPH AT	1	0.10	1	150.	299.	374.	449.	524.	599.	749.	1123.	1497.
	(	0.27)	(	4.24)(	8.48)(	10.60)(	12.72)(	14.84)(	16.96)(	21.20)(	31.80)(	42.40)
ROUTED TO	2	0.10	1	50.	122.	172.	264.	378.	476.	645.	1086.	1478.
	(	0.27)	(	1.42)(	3.45)(	4.88)(	7.48)(	10.71)(	13.47)(	18.26)(	30.75)(	41.86)
HYDROGRAPH AT	3	0.15	1	218.	435.	544.	653.	762.	871.	1089.	1633.	2177.
	(	0.39)	(	6.16)(	12.33)(	15.41)(	18.49)(	21.58)(	24.66)(	30.82)(	46.23)(	61.65)
2 COMBINED	4	0.26	1	256.	525.	675.	832.	1053.	1290.	1733.	2719.	3655.
	(	0.67)	(	7.26)(	14.86)(	19.10)(	23.56)(	29.81)(	36.52)(	49.09)(	76.99)(	103.51)
ROUTED TO	5	0.26	1	65.	215.	336.	463.	598.	758.	1141.	2174.	3070.
	(	0.67)	(	1.83)(	6.09)(	9.51)(	13.11)(	16.94)(	21.46)(	32.30)(	61.55)(	86.94)

SUMMARY OF DAM SAFETY ANALYSIS

PMF RATIOS
OUTPUT DATA (1-2)
ASSUMING NO BREACH
OF THE UPPER DAM

SUMMARY OF DAM SAFETY ANALYSIS

UPPER DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	947.30	947.30	949.50
STORAGE	41.	41.	53.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	948.40	0.00	47.	50.	0.00	15.92	0.00
0.20	949.22	0.00	51.	122.	0.00	15.83	0.00
0.25	949.54	0.04	53.	172.	0.17	15.83	0.00
0.30	949.72	0.22	54.	264.	0.50	15.75	0.00
0.35	949.86	0.36	55.	378.	0.50	15.75	0.00
0.40	949.96	0.46	56.	476.	0.67	15.75	0.00
0.50	950.09	0.59	57.	645.	0.92	15.67	0.00
0.75	950.35	0.85	59.	1086.	3.17	15.67	0.00
1.00	950.55	1.05	60.	1478.	5.00	15.67	0.00

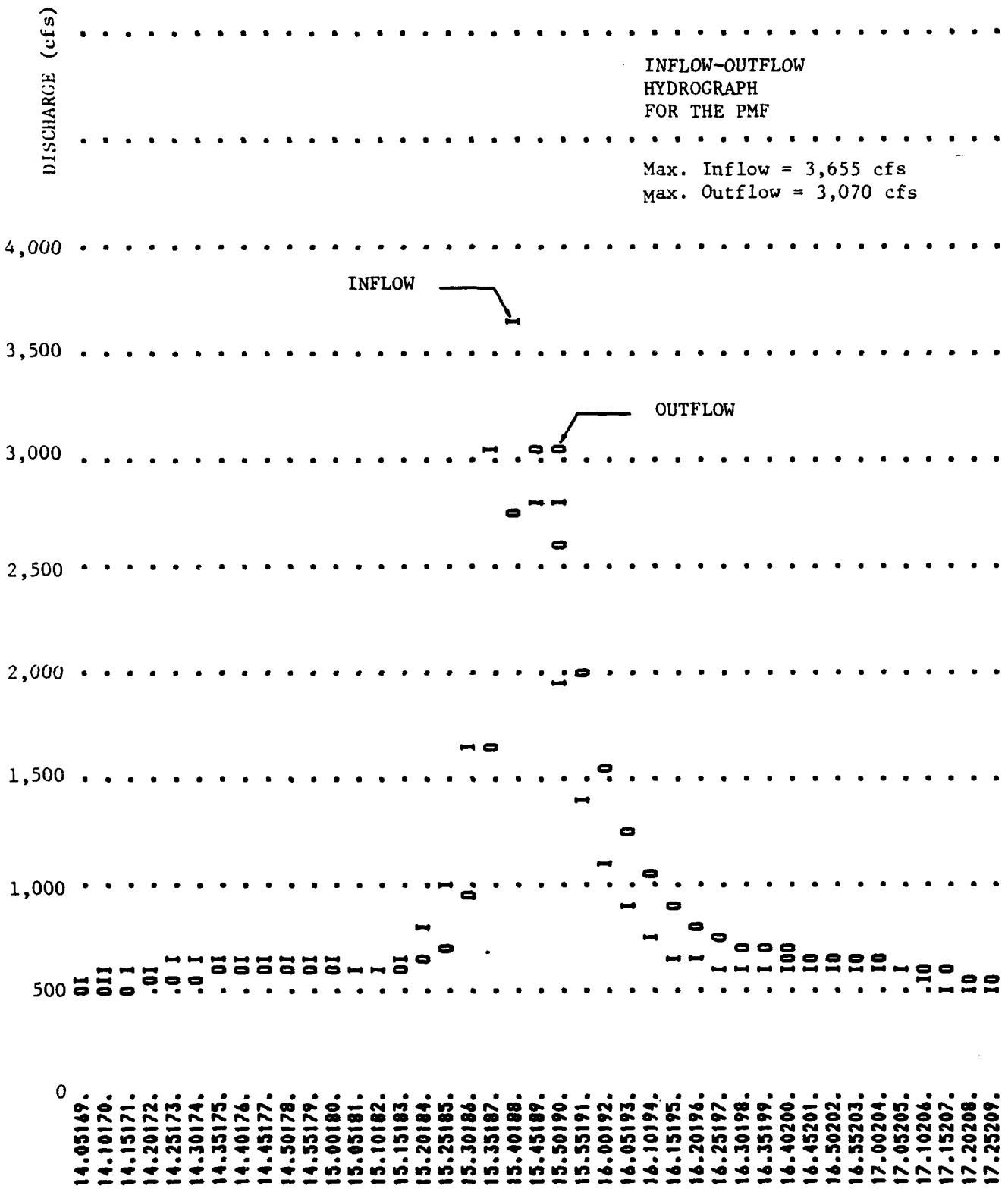
SUMMARY OF DAM SAFETY ANALYSIS

STUBBLEFIELD LAKE DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	930.10	930.10	932.50
STORAGE	140.	140.	177.
OUTFLOW	0.	0.	455.

PMF RATIOS
OUTPUT DATA (2-2)
ASSUMING NO BREACH OF
THE UPPER DAM

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	931.30	0.00	158.	65.	0.00	17.08	0.00
0.20	932.01	0.00	169.	215.	0.00	16.08	0.00
0.25	932.26	0.00	173.	336.	0.00	15.92	0.00
0.30	932.51	0.01	177.	463.	0.08	15.92	0.00
0.35	932.71	0.21	181.	598.	0.50	15.92	0.00
0.40	932.90	0.40	185.	758.	0.75	15.83	0.00
0.50	933.15	0.65	190.	1141.	1.00	15.83	0.00
0.75	933.59	1.09	198.	2174.	2.08	15.75	0.00
1.00	933.91	1.41	205.	3070.	4.42	15.75	0.00


DISCHARGE (cfs)
INFLOW-OUTFLOW
HYDROGRAPH
FOR THE PMF
Max. Inflow = 3,655 cfs
Max. Outflow = 3,070 cfs
INFLOW
OUTFLOW
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
14.05169.
14.10170.
14.15171.
14.20172.
14.25173.
14.30174.
14.35175.
14.40176.
14.45177.
14.50178.
14.55179.
15.00180.
15.05181.
15.10182.
15.15183.
15.20184.
15.25185.
15.30186.
15.35187.
15.40188.
15.45189.
15.50190.
15.55191.
16.00192.
16.05193.
16.10194.
16.15195.
16.20196.
16.25197.
16.30198.
16.35199.
16.40200.
16.45201.
16.50202.
16.55203.
17.00204.
17.05205.
17.10206.
17.15207.
17.20208.
17.25209.
TIME (hrs)

```
A       OVERTOPPING ANALYSIS FOR STUBBLEFIELD LAKE DAM ( # 25 )
A       STATE ID NO. 30363  COUNTY NAME : CRAUFORD
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 80S3001
B    300                5
B1     5
J      2       1       1
J1   1.0
K      0       1                                5       1
K1      INFLOW HYDROGRAPH COMPUTATION FOR THE UPPER LAKE
M      1       2   0.105           0.105       1                       1
P      0    25.7     102     120     130
T                                                       -1     -82             0.10
W2  0.14    0.09
X      0     -.1       2
K      1       2                          0       4       1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE (UPPER DAM)
Y                                  1       1
Y1     1                                                41      -1
Y4 947.3   948.0   949.0   949.5   950.0   950.9   951.7
Y5     0      22      92     160     240     550     885
$S     0      41      53      63      97     152
$E 927.8   947.3   949.5   951.0   955.0   960.0
$$ 947.3
$D 949.5
$L   190     290     390     490
$V 949.5   949.8   950.1   952.1
$B    10     0.5   930.0     0.5   947.3   950.5
$B    10     0.5   930.0     1.0   947.3   950.5
K      0       3                                5       1
K1      INFLOW HYDROGRAPH COMPUTATION FOR THE LOWER LAKE (STUBBLEFIELD LAKE)
M      1       2   0.152           0.152       1                       1
P      0    25.7     102     120     130
T                                                       -1     -85             0.14
W2  0.16    0.10
X      0     -.1       2
K      2       4                                5       1
K1      COMBINE OUTFLOW HYDROGRAPH FROM UPPER LAKE AND INFLOW HYD.FOR STUBBLEFIELD LAKE
K      1       5                          0       4       1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT STUBBLEFIELD DAM SITE **
Y                                  1       1
Y1     1                                                    140      -1
Y4 930.1   931.2   931.4   932.0   932.5   932.8  933.25   934.0   934.4
Y5     0      50      80     210     455     650    1020    1850    2470
$S     0     140     159     177     226     360
$E 904.0   930.1   931.4   932.5   935.0   940.0
$$ 930.1
$D 932.5
$L     0      60     230     400     400     400     400
$V 932.5   932.8   932.9   933.0   933.5   934.0   935.0
K     99
```

PMF INPUT DATA
ASSUMING BREACH OF THE
UPPER DAM

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00
HYDROGRAPH AT	1	0.10	1	1497.
	(	0.27)	(	42.40)(
			2	1497.
			(	42.40)(
ROUTED TO	2	0.10	1	1862.
	(	0.27)	(	52.74)(
			2	1479.
			(	41.87)(
HYDROGRAPH AT	3	0.15	1	2177.
	(	0.39)	(	61.65)(
			2	2177.
			(	61.65)(
2 COMBINED	4	0.26	1	3656.
	(	0.67)	(	103.52)(
			2	3656.
			(	103.52)(
ROUTED TO	5	0.26	1	2980.
	(	0.67)	(	84.38)(
			2	2918.
			(	82.63)(

SUMMARY OF DAM SAFETY ANALYSIS

PMF OUTPUT DATA (1-2)
ASSUMING BREACH OF THE
UPPER DAM

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	947.30	947.30	949.50
STORAGE	41.	41.	53.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	951.02	1.52	63.	1997.	2.69	16.04	15.67

PLAN 2	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	947.30	947.30	949.50
STORAGE	41.	41.	53.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	951.07	1.57	64.	1479.	2.81	15.67	15.67

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	930.10	930.10	932.50
STORAGE	140.	140.	177.
OUTFLOW	0.	0.	455.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	933.88	1.38	204.	2980.	4.42	15.75	0.00

PLAN 2	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	930.10	930.10	932.50
STORAGE	140.	140.	177.
OUTFLOW	0.	0.	455.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	933.86	1.36	204.	2918.	4.42	15.75	0.00

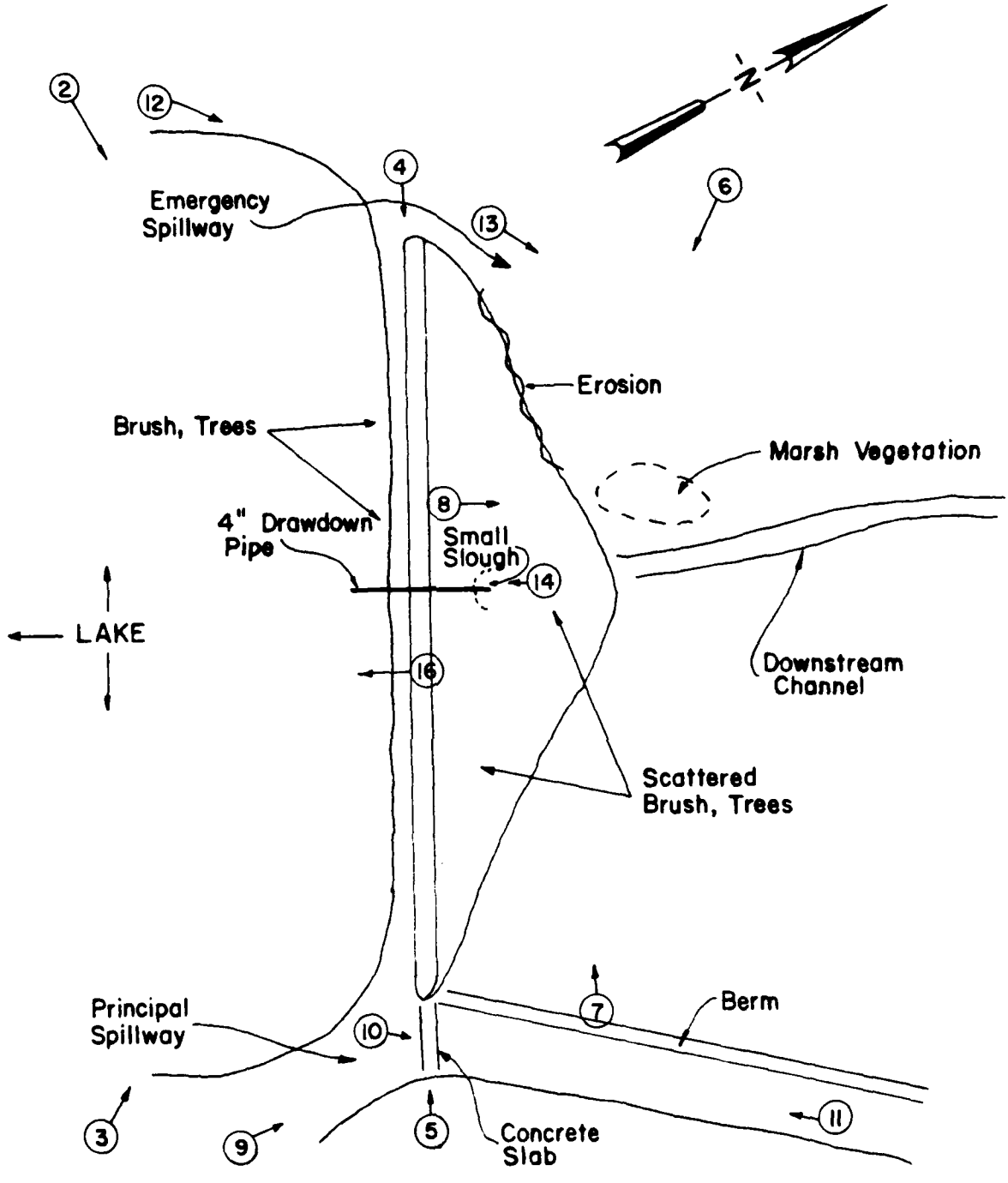
PMF OUTPUT DATA (2-2)
ASSUMING BREACH OF THE
UPPER DAM

APPENDIX D

Photographs

LIST OF PHOTOGRAPHS

Photo No.	Description
1.	Aerial view of lake and dam, looking south.
2.	Upstream face of dam, looking east from left abutment; note trees and brush.
3.	Upstream face of dam, looking northwest from right abutment.
4.	Crest of dam, looking east from left abutment.
5.	Crest of dam, looking west from right abutment.
6.	Downstream face of dam, looking east from left abutment.
7.	Downstream face of dam, looking west from right abutment.
8.	Area of marsh vegetation, looking north from crest of dam.
9.	Approach to principal spillway, looking north from right side of lake.
10.	Principal spillway, looking downstream from crest; note concrete slab in foreground and berm on left.
11.	Principal spillway, looking upstream, berm on right.
12.	Approach area of emergency spillway, looking north.
13.	Emergency spillway, looking downstream from crest.
14.	Outlet of 4 in. drawdown pipe; note disturbed area above pipe.
15.	Crest of upper dam, looking southwest from right abutment.
16.	View of Stubblefield Lake, looking upstream from crest.



PHOTOGRAPH LOCATIONS

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Stubblefield Lake Dam
Crawford County, Missouri
Mo I D No 30363

Sheet 2, Appendix D


1


4


5


6

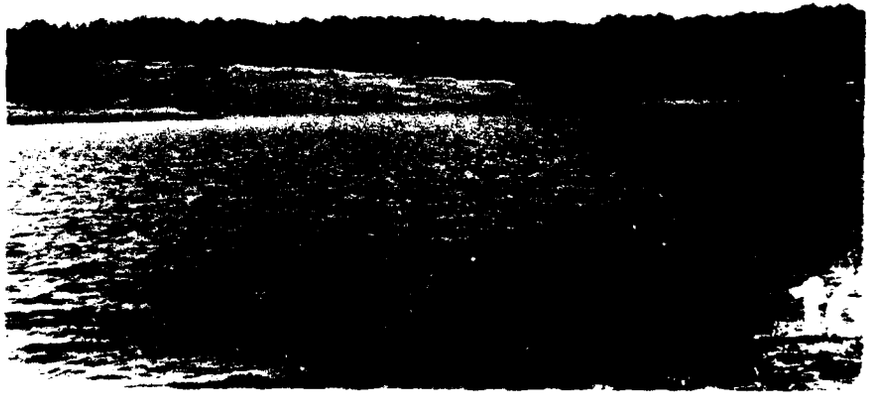

8

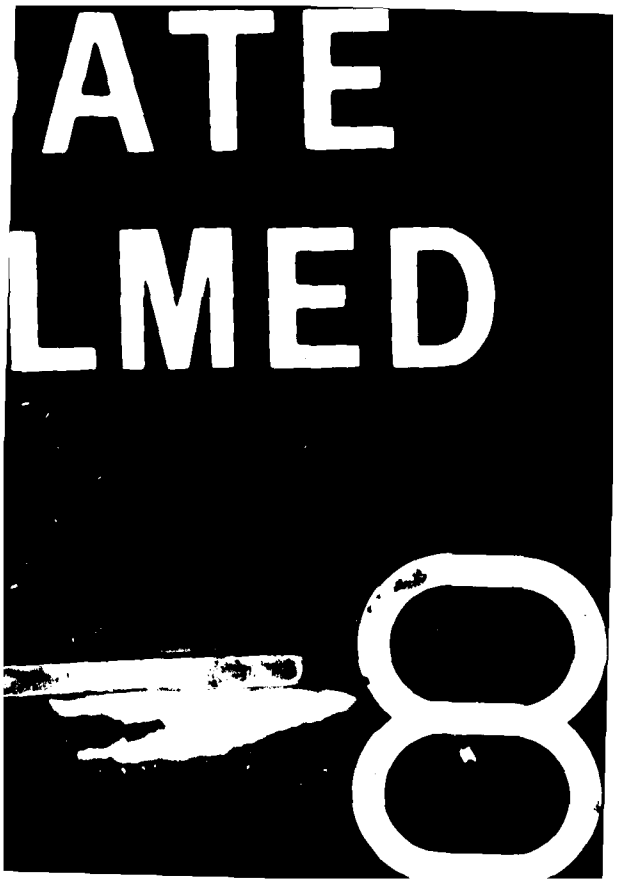

9


10


11


15

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8